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Transvenous Embolization of Dural Arteriovenous Fistula of the Cavernous Sinus

Fistulous Points and Route of Catheterization

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Key words: dural arteriovenous fistula, cavernous sinus, transvenous embolization, MRI, fistulous point, 3-D fast SPGR, contrast-enhanced

Summary

We reviewed magnetic resonance (MR) images and digital subtraction angiograms (DSA) from eight patients with dural arteriovenous fistula of the cavernous sinus (DAVFCS) to clarify the fistulous points and to evaluate the venous access routes into the cavernous sinus for transvenous embolization (TVE).

Multiplanar reconstruction of the MR images was achieved using three-dimensional fast spoiled gradient-recalled acquisition in the steady state (3-D fast SPGR) after the intravenous administration of gadopentetate dimeglumine (Gd-DTPA).

TVE was performed using microcoils via the inferior petrosal sinus (IPS) using the transfemoral approach in five patients, via the facial vein and superior ophthalmic vein (SOV) using the transfemoral approach in 1 patient, and by SOV puncture in two patients. Most fistulas were detected in the posterior portion of the cavernous sinus or in the posterior intercavernous sinus in all of the patients. Fistulas identified as hyperintense dots or lines on contrast-enhanced 3-D fast SPGR images and were replaced with the microcoils. Target embolization of the fistulas was feasible in three patients treated via the SOV and in one patient treated via the IPS. Contrast-enhanced 3-D fast SPGR can help to identify the fistulous points of DAVFCS. Precise identification of fistulous points and selection of the adequate access route are mandatory for efficient TVE of DAVFCS.

Introduction

Transvenous embolization (TVE) is now considered as a curative treatment for dural arteriovenous fistula of the cavernous sinus (DAVFCS) [1-6]. This procedure was originally performed by puncturing the superior ophthalmic vein (SOV) [1,2,7], but is now performed via the inferior petrosal sinus (IPS) using the transfemoral approach [3-6]. We routinely start embolization far from the IPS including the junction with the SOV or the sphenoparietal sinus and embolize the whole cavernous sinus pulling the catheter back.

This is because navigating a microcatheter through packed microcoils might be difficult when the SOV and sphenoparietal sinus remain as drainage routes of DAVFCS [4]. However, the non-fistulous portion is also embolized in the current method, if the fistula is situated posteriorly in the cavernous sinus as Newton et Al [8] described. We reviewed our consecutive series to evaluate the location of fistulas and the feasibility of restricted transvenous target embolization of fistulas.

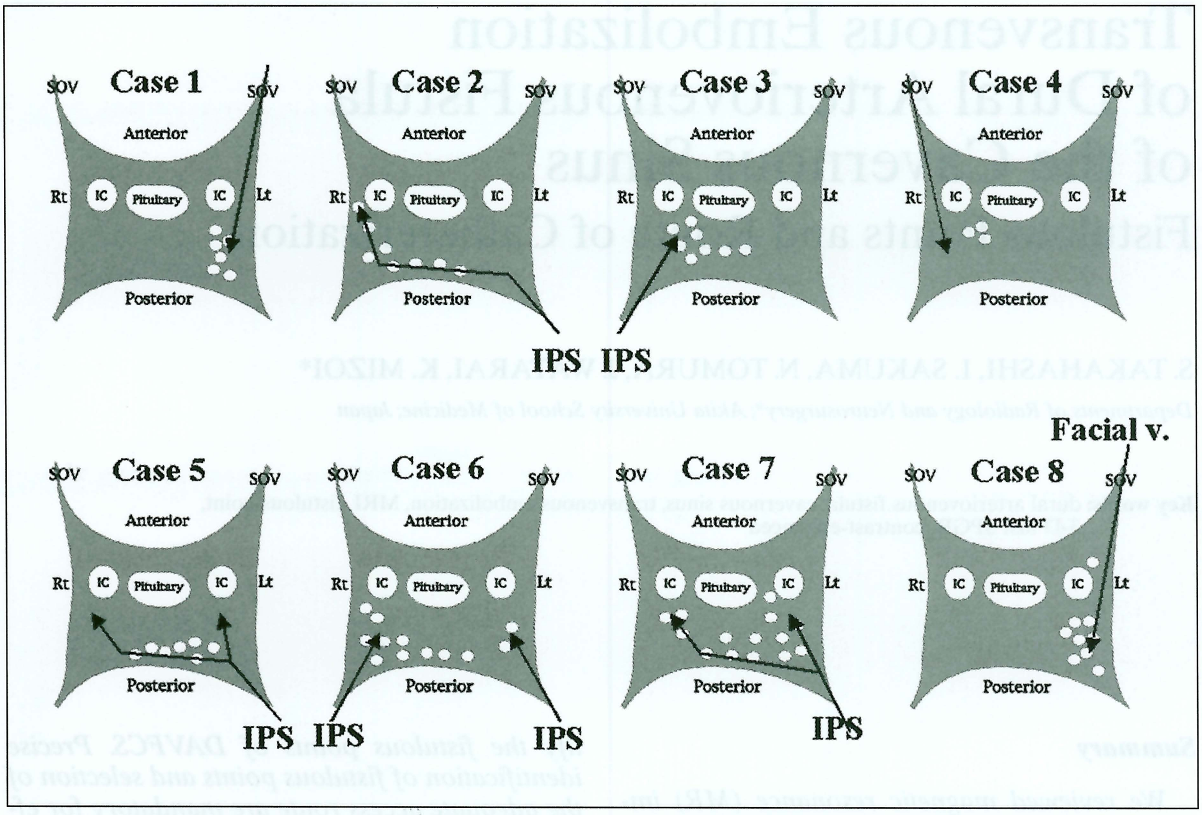

Figure 1 Cavernous sinus: fistulous points and venous access routes. Fistulous points are shown as white dots in the cavernous sinus from axial source images obtained by contrast-enhanced 3-D fast SPGR. Black arrows reveal venous access routes in TVE. IC, internal carotid artery; pituitary, pituitary gland; Rt, right; Lt, left; SOV, superior ophthalmic vein; IPS, inferior petrosal sinus; Facial v., facial vein.

Material and Methods

Eight consecutive patients (one male and seven females; age range, 52-77 years; mean age, 66.2 years) with DAVFCS were treated by TVE using interlocking detachable coils (IDCs) and fibered platinum coils (FPCs). All patients underwent MRI within one week before TVE and one-two weeks after TVE. Three-dimensional fast spoiled gradient-recalled acquisition in the steady state (3-D fast SPGR) was performed after the intravenous administration of gadopentetate dimeglumine (Gd-DTPA) using 1.5-T superconductive units with the following parameters: repetition time/echo time/excitations, 11-13/2-3/1-2; 18 cm field of view, 1 mm slice thickness, 60 slices, 256 x 192-224 matrix. The saturation pulse was not used above the volume slab. The cavernous sinus was located at the center of the slab. Axial source images and reconstructed sagittal and coronal images were displayed on the Advantage Window Console and the location and number of abnormal hyperintense areas of the cavernous sinuses were evaluated before and after TVE. The cavernous sinus was divided approximately into 4 segments antero-posteriorly and bilaterally by the midline on the axial plane. The location of abnormal hyperintensity of the cavernous sinus was compared with the early arterial phase of digital subtraction angiography (DSA) to identify fistulous points.

All patients had complained of ophthalmopathy or pulsatile tinnitus. Though TVE was attempted via the IPS using the transfemoral approach in seven patients, catheterization into the affected cavernous sinus failed in two of them. This was because ipsilateral IPS was not identified presumably due to thrombosis in one and due to stenosis by compression of the temporal bone tumor in another. We therefore performed TVE by puncture of the SOV in these

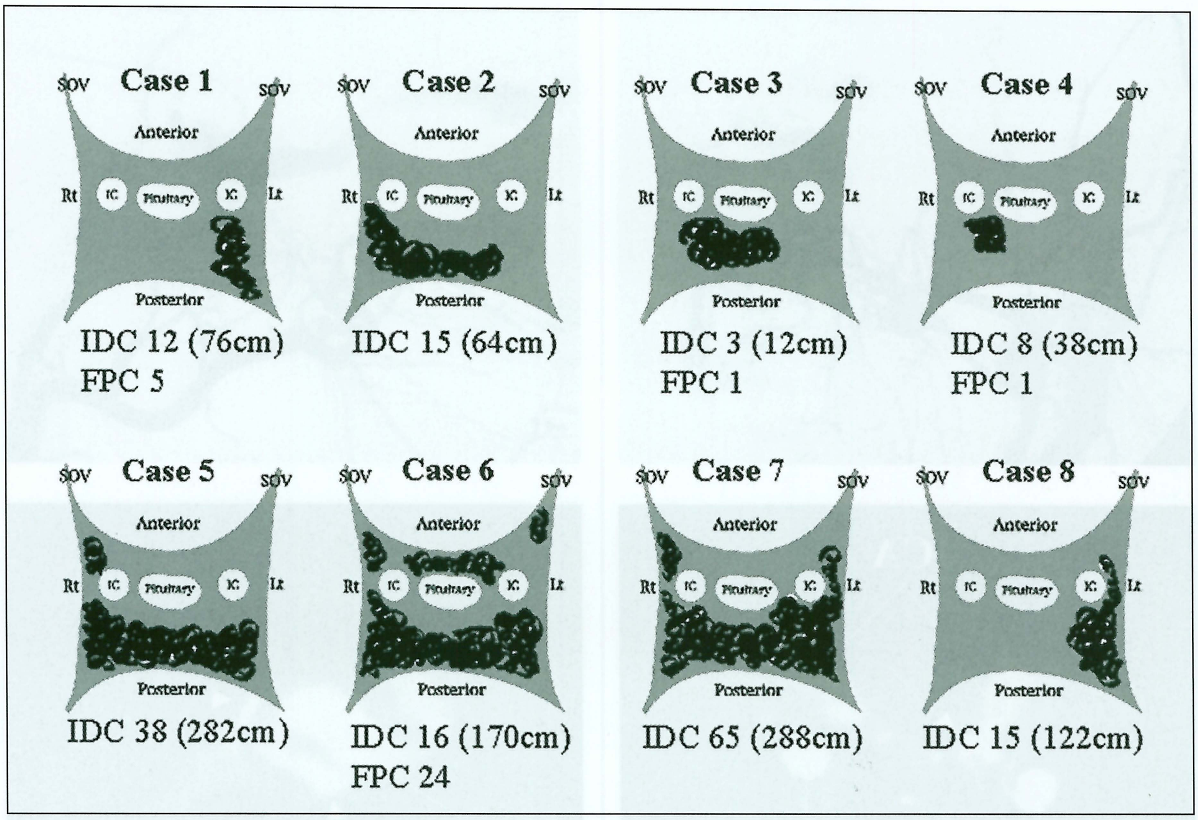

Figure 2 Microcoils positioned in the cavernous sinus. Microcoils placed in the cavernous sinus are illustrated as black tangles. Numbers of IDCs and FPCs are described below the illustration. Numbers in parentheses are total lengths of IDCs. IDC, interlocking detachable coil; FPC, fibered platinum coil.

two patients. In one recent patient, TVE was performed via the facial vein-SOV route using the transfemoral approach. Coils were intensely packed at sites of abnormal hyperintensity of the cavernous sinuses demonstrated by contrast-enhanced 3-D fast SPGR in all patients. Follow up angiography was performed within 1-3 months after TVE.

Results

DAVFCS disappeared angiographically and symptoms resolved in all patients. Abnormal hyperintensity by contrast-enhanced 3-D fast SPGR before TVE appeared as dots or lines mainly at the posterior portion of the cavernous sinus in all patients and was demonstrated bilaterally including the posterior intercavernous sinus in five patients. The location of the hyperintensity was in accord with the fistulous points identified by DSA in all patients. Abnormal hyperintensity was replaced by the microcoils after TVE. Figure 1 shows abnormal hyperintensity of the cavernous sinus based on axial source images obtained by contrast-enhanced 3-D fast SPGR and also shows the transvenous access routes for TVE. Figure 2 shows the microcoils positioned in the cavernous sinus.

Target embolization of fistulas was feasible in 3 patients treated via the SOV and in 1 patient treated via the IPS. Fewer microcoils were needed to obliterate fistulas in these patients. Because scattered fistulas were situated in the posterior portion of the cavernous sinuses and in the posterior intercavernous sinus in the other patients treated via the IPS, many microcoils were required to obliterate the fistulas. Fistulas in case 6 were situated mainly in the posterior portion of the bilateral cavernous sinuses and in the posterior intercavernous sinus. Thus, TVE was performed in the left cavernous, pos-

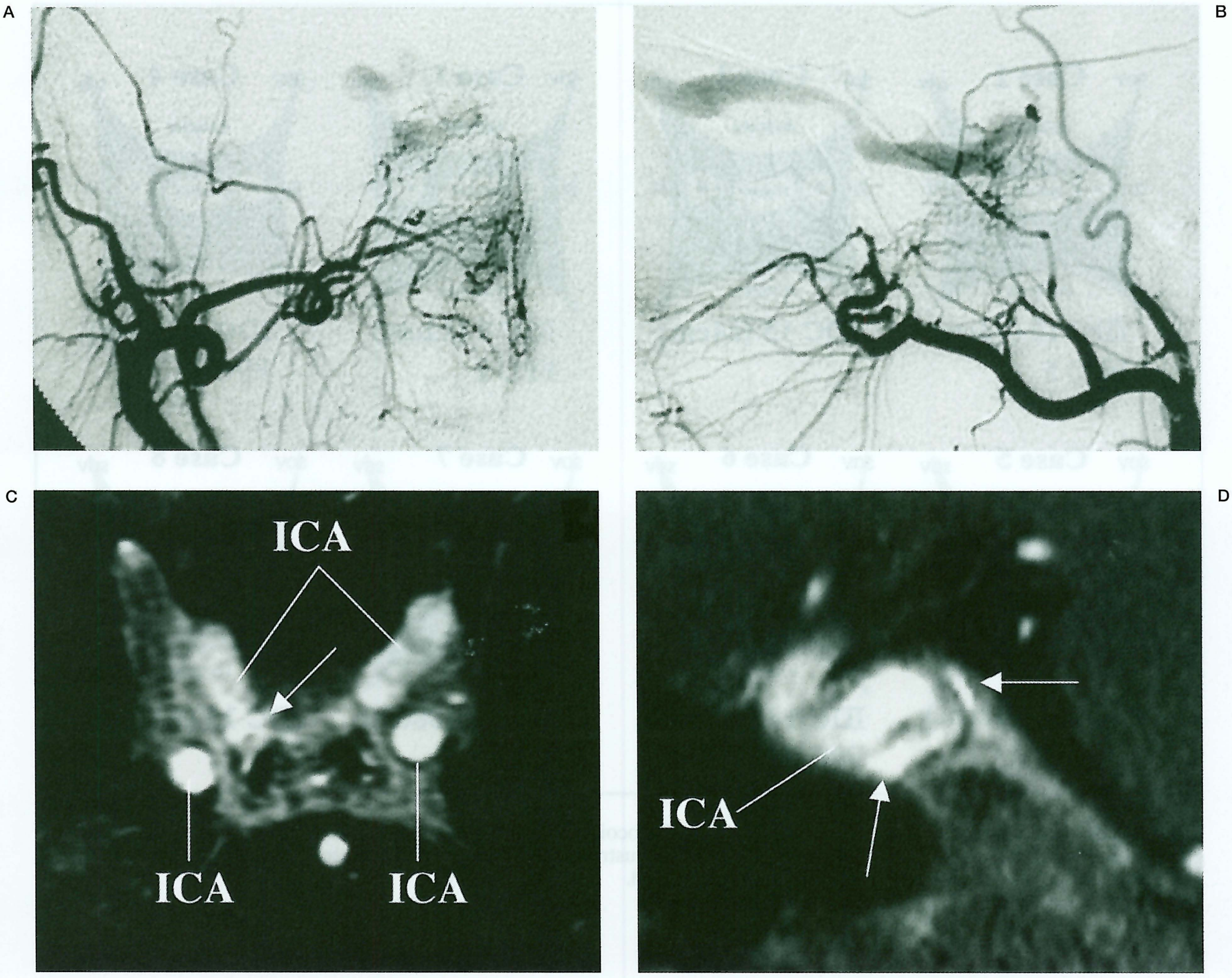

Figure 3 Case 4. Right external carotid arteriogram, frontal (A) and lateral (B) projections, shows DAVF of the right cavernous sinus with venous drainage into the right superior ophthalmic vein. The axial source image (C) and reconstructed sagittal image (D) obtained by contrast-enhanced 3-D fast SPGR show the point-shaped or linear hyperintensity (arrows) abutting the right internal carotid artery in the right cavernous sinus.
ICA, internal carotid artery.

terior intercavernous and right cavernous sinuses, in that order via bilateral IPS. Though we attempted restricted coil packing at the posterior portion of the right cavernous sinus in which most fistulas were situated, the venous drainage of DAVF was diverted from the right IPS into the right SOV during TVE. Thus, the microcatheter was navigated into the SOV through the microcoils and TVE was accomplished to obliterate residual fistulas.

Discussion

The approach via the IPS has recently become accepted in TVE of DAVFCS3-6. This is because the approach is less invasive than that by SOV puncture and catheterization into the IPS is feasible in most patients even if the IPS is not opaque in cerebral arteriography[3-6]. In this method, the order of embolization is important[4]. If the SOV and sphenoparietal sinus remain as drainage routes of DAVFCS, packed coils will prevent navigation of a microcatheter into the drainage routes.

Therefore, embolization must be started far from the IPS even if fistulas are not situated at that region[4].

Few reports have described the location of fistulas of DAVFCS. Newton et Al[8] described that fistulas of DAVFCS were usually posteri-

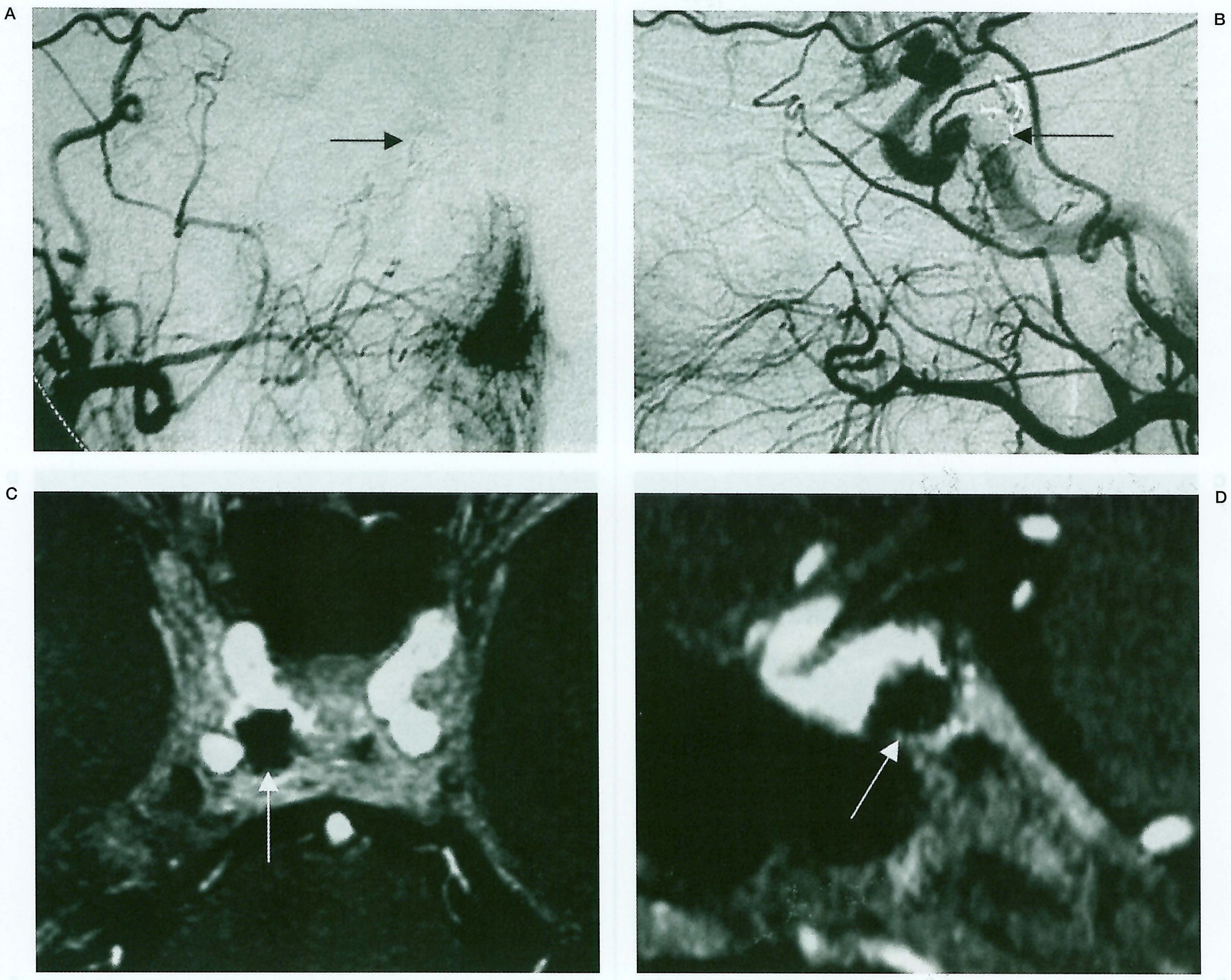

Figure 4 Case 4. Right external carotid arteriogram, fronal (A) and lateral (B) projections, immediately after TVE using microcoils (arrows) shows disappearance of DAVF. The axial source image (C) and reconstructed sagittal image (D) obtained by contrast-enhanced 3-D fast SPGR show the microcoils placed on the fistulous points (arrows).

orly situated in the cavernous sinus, an observation with which our data agree. Source images of MR angiography (MRA) can reveal abnormal hyperintensity in the cavernous sinus of DAVFCS [9,10].

Hirai et Al [10] described that the hyperintensity might correspond to meningeal arteries of the external and internal carotid arteries, representing feeding pedicles. They also described that contrast-enhanced MRI disturbed the information of the cavernous sinus, because the cavernous sinuses were homogenously enhanced. However, we discovered that adjusting the window level and width could distinguish abnormal hyperintensity obtained by contrast-enhanced 3-D fast SPGR from enhanced cavernous sinus. Contrast-enhanced MRI can delineate the cavernous sinus more precisely compared with non-contrast study [11]. Therefore, it is easy to recognize the location of fistulas in the cavernous sinus. What the abnormal hyperintensity in fact means is controversial, as it could be dilated meningeal arteries or veins [10]. However, it revealed mostly fistulous points in our study. Axial source images and reconstructed sagittal and coronal images obtained by contrast-enhanced 3-D fast SPGR were very useful for identifying fistulous points and for planning TVE. Target embolization of fistulas was feasible in three patients treated via the SOV and in

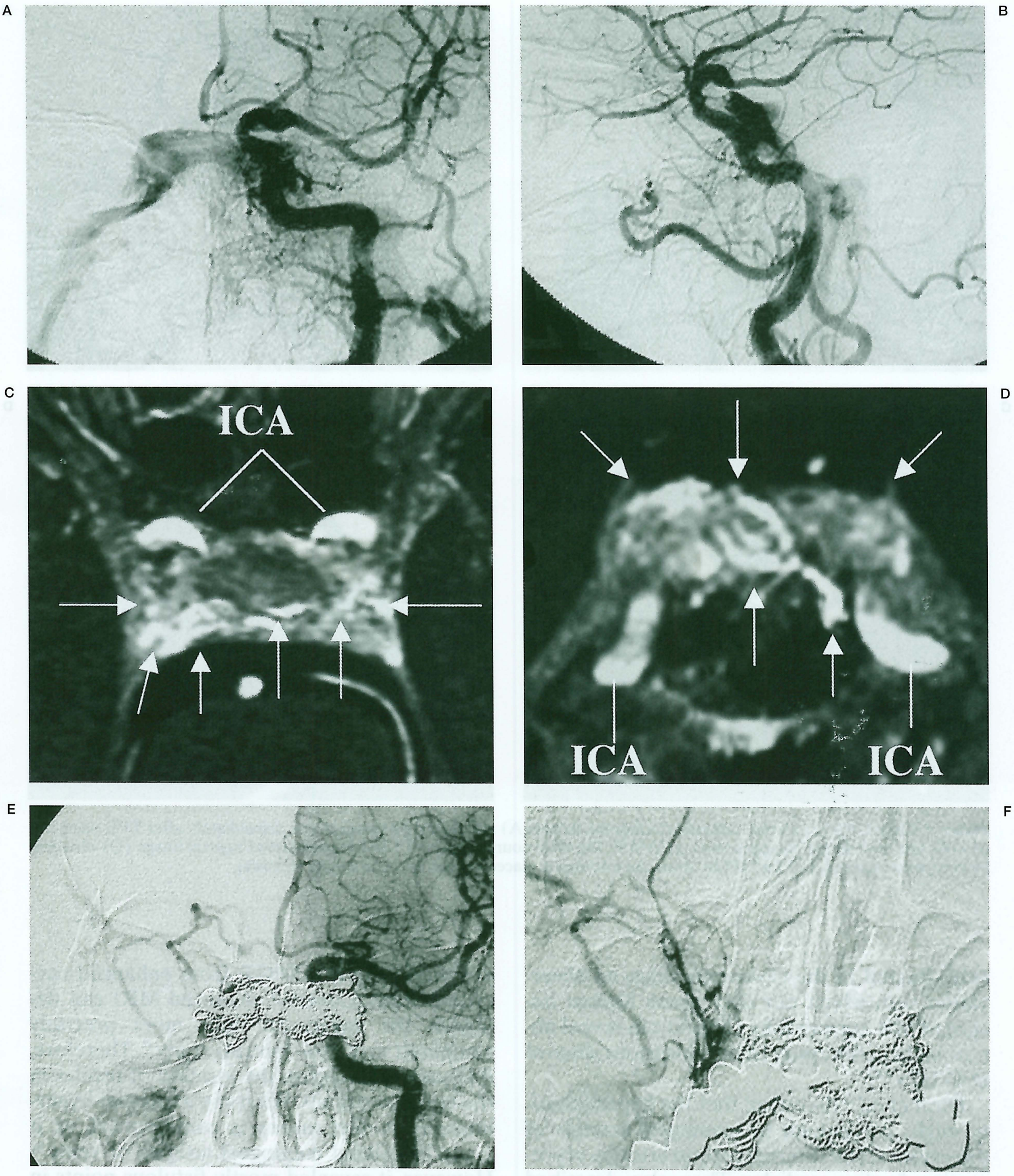

Figure 5 Case 6. Left common carotid arteriogram, frontal (A) and lateral (B) projections, show DAVFCS draining into the bilateral IPS. The axial source image of the cavernous sinus (C) and the reconstructed coronal image of the posterior intercavernous sinus (D) obtained by contrast-enhanced 3-D fast SPGR show the multiple hyperintense curvilinear structures (arrows) posteriorly in bilateral cavenous sinuses and the posterior intercavernous sinus. Left internal carotid arteriogram, frontal view (E), during coil packing of the right cavernous sinus shows residual DAVF with venous drainage into the right SOV diverted from the right IPS. Right SOV injection, basal view (F), after the navigation of the microcatheter through the placed microcoils shows the residual space of the right cavernous sinus and right SOV.
ICA, internal carotid artery.

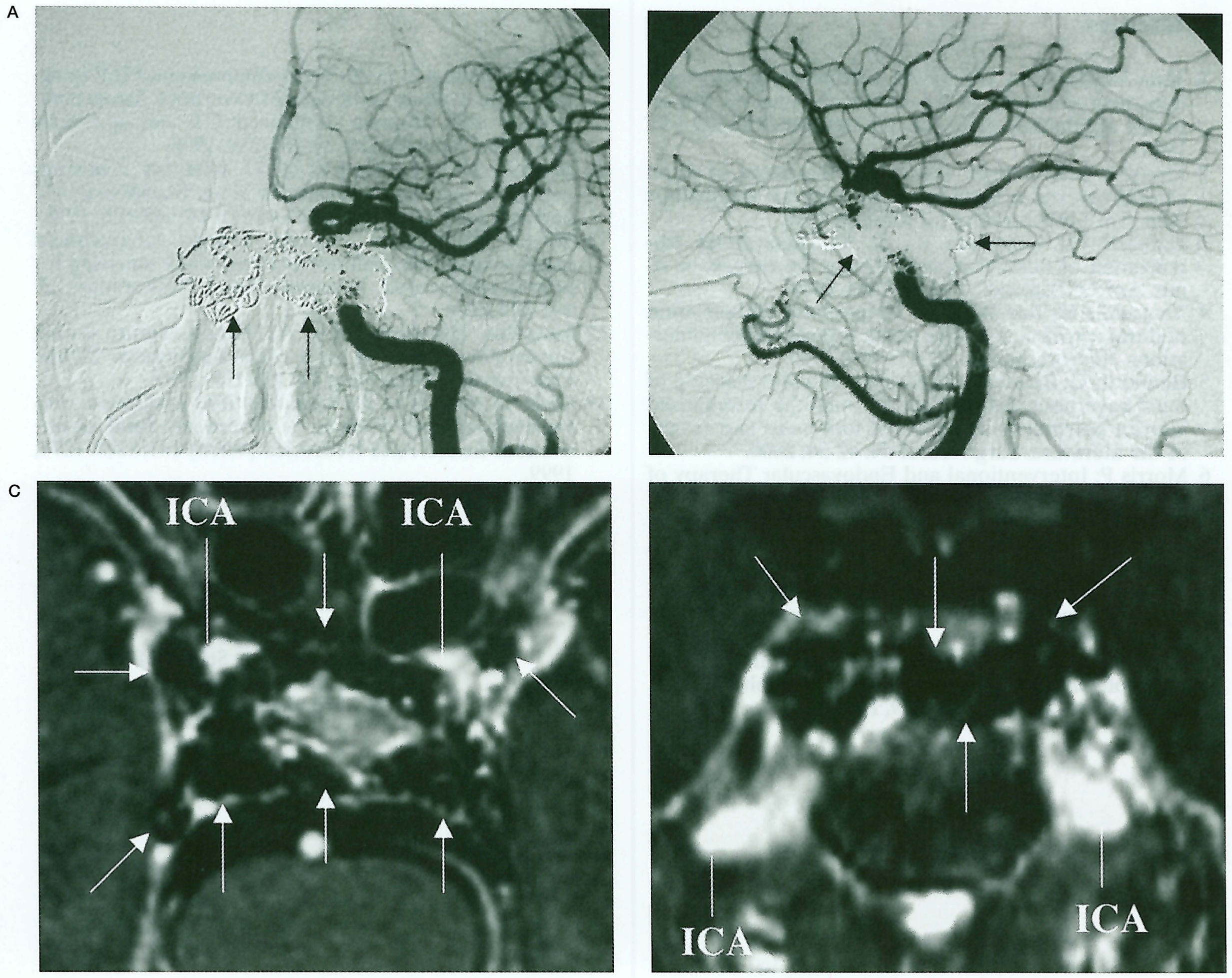

Figure 6 Case 6. Right common carotid arteriogram, fronal (A) and lateral (B) projections, immediately after TVE using microcoils (arrows) shows disappearance of DAVF. The axial source image (C) and reconstructed coronal image (D) obtained by contrast-enhanced 3-D fast SPGR show the microcoils (arrows) placed in bilateral cavernous sinuses and the posterior intercavernous sinus. ICA, internal carotid artery.

one treated via the IPS. In the three patients treated via the SOV, coil packing was started from the posterior portion of the cavernous sinus in which fistulas were situated. Thus, TVE could be finished when control arteriography confirmed the disappearance of DAVF, which resulted in target embolization. In the one patient treated via the IPS, because fistulas were situated at a limited portion, target embolization was feasible. However, target embolization via the IPS was difficult in the patient with scattered fistulas at the bilateral cavernous sinuses or posterior intercavernous sinus.

Target embolization was feasible for one recent patient who was embolized via the facial vein-SOV route by the transfemoral approach. This method is less invasive than SOV puncture and is free from complication by subarachnoid haemorrhage [12,13] or dissection of the clival dura [14] because the route runs through the extracranial portion. The method has the feasibility of target embolization in patients with unilateral DAVFCS.

Conclusions

Contrast-enhanced 3-D fast SPGR is helpful to identify fistulous points of DAVFCS. Fistulas were mainly situated at the posterior portion of the cavernous sinus in all eight patients in our study. Precise identification of fistulas and selection of the optimal access route are mandatory for efficient TVE of DAVFCS.

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